



**Patent Application of Franklin Zhigang Zhang
for**

TITLE: Multi-Channel Redundant Wireless Network Link and Device

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CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of the Provisional Patent Application Ser.No.
10 60/254,393 filed 12/08/2000.

BACKGROUND – FIELD OF INVENTION

This invention is concerned with outdoor wireless networking system and devices,
15 specifically, an outdoor high bandwidth wireless network link with multiple
redundancies.

BACKGROUND – DESCRIPTION OF PRIOR ART

5 In the art of outdoor wireless network communication, the communication links among the wireless point of presence (WPOP) are to provide main bandwidth supply to the rest of the transmitting equipments which service the remote clients. This kind of network communication link is normally considered as backbone link for wireless networking. There are wired backbone link and wireless backbone links.

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The basic requirements of the backbone link are high bandwidth and high reliability. A LMDS wireless communication system is a very common backbone link of wireless communication. To meet the requirements, a LMDS system uses high quality microwave components and other electronics parts to ensure high reliability. LMDS
15 system also adopts high radio frequency band to provide the high bandwidth for the connectivity, and, a LMDS system is high cost and hard to deploy.

To improve the reliability of the backbone wireless communication, it is not enough by only improve the equipment quality itself; redundancy is a very important and
20 common technology. Some LMDS radio systems have two-radio redundancy modular design. Sometimes, a third location of topology is established in order to achieve the redundancy of the whole communication. More high-grade equipments such as switches and routers need to be deployed to setup a third location redundancy.

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In the prior art of the wireless backbone technology, cost and how to achieve the redundancy is a big issue. LMDS radio system itself is very expensive, the high frequency design causes users to pay bandwidth usage fee, and, further more, the high frequency microwave system cannot communicate over far distance. Setting up
30 an third topology redundancy site, is not only extra high cost, but also, the suitable location is not always available. Accordingly, most wireless networks and their

backbone are working in the non-redundancy status.

Obviously, a better solution is needed.

Summary

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A Multi-Channel Redundant Wireless Network Link (RWNL) device comprises a plurality of wireless networking radio units. Each of the plurality of the wireless networking radio units communicates with the correspondent radio unit of the remote RWNL device, and forms a child wireless link. Two RWNL devices communicating with each other form a multiple redundancies wireless network link. The multiple redundancies wireless network link aggregate the communication capability of the entire child wireless links to be a big redundant wireless network link.

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Objects and Advantages

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Accordingly, several objects and advantages of my invention are:

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- 1) to provide ultra high reliable wireless network communication link with multiple redundancy;
- 2) to provide a high bandwidth low cost wireless communication backbone link and devices;
- 3) to provide longer distance of wireless backbone link;

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The forgoing features and advantages of the present invention can be appreciated more fully from the following description, with references to the accompanying drawings in which.

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Brief Description of the Drawings

Fig. 1 is a block schematic diagram of a Multi-Channel Redundant Wireless Network
5 Link device with 4 radio channels.

Fig. 2 is a schematic block representation of the system function of a RWNL device
with 4 radio channels of the present invention.

10 Fig.3 is a schematic block representation of redundant wireless link formed by two
RWNL devices with 4 radio channels.

SUMMARY

15 A Multi-Channel Redundant Wireless Network Link (RWNL) device comprises
a plurality of wireless networking radio units. Each of the plurality of the wireless
networking radio units communicates with the correspondent radio unit of the remote
RWNL device, and forms a child wireless link. Two RWNL devices communicating with
each other form a multiple redundancies wireless network link. The multiple
20 redundancies wireless network link aggregate the communication capability of the
entire child wireless links to be a big redundant wireless network link.

DESCRIPTION-Preferred Embodiment

25 Fig. 1 is a block schematic diagram of a Multi-Channel Redundant Wireless Network
Link (RWNL) device with 4 radio channels. As shown, the RWNL device 10 in this
embodiment comprises four radio channels: radio1 111 and antenna 101 form the radio
channel1; radio2 112 and antenna 102 form the radio channel2; radio3 113 and
antenna 103 form the radio channel3; radio4 114 and antenna 104 form the radio
30 channel 4. The RWNL device 10 may comprises two or more than two radio channels.

The microwave designs are required to ensure these channels will not interference with each other. In this embodiment, the RWNL device 10 also comprises a processor unit 110; a control unit 109; two system buses 107, 108; and a wired port unit 115 through which the RWNL device 10 can be connected to a LAN. For some types of the radio, the interface unit is needed. In this embodiment, radio1 111 is connected to BUS I 107 via the interface unit 105; radio2 112 is connected to BUS I 107 via the interface unit 106. Radio3 113 and radio4 114 do not require an interface, and are directly connected to BUS I 107 and BUS II 108.

Fig. 2 is a schematic block representation of the system function of a RWNL device with 4 radio channels of the present invention. The RWNL device may have more than one feature wired network port unit 307, 308, at least one of them are working at virtual port mode. The wired network port units receive and transmit the wired networking packets from/to the wired LAN. Once the wired port 307, 308 receive networking packets from LAN, they will hand over the packet to packet flow control unit 201 if the destination of the packet needs to be transmitted over the wireless link. Even though there are more than one wireless communication channel exist, the wired port unit always thinks the only one wireless channel to transmit the packets.

The packet flow control unit 201 represents to the wired port units 307, 308 as one wireless networking unit. When the packet flow control unit 201 receives the networking packets from the wired port units 307, 308, these packets are distributed through each of the multiple radio networking units. In this embodiment, the RWNL device comprises four radio-networking units 203,204,205,206. The radio-networking unit 203 representing the functions of the radio1 channel 101 and 111 of the fig.1; The radio-networking unit 204 representing the functions of the radio2 channel 102 and 112 of the fig.1; The radio-networking unit 205 representing the functions of the radio3 channel 103 and 113 of the fig.1; the radio-networking unit 206 representing the functions of the radio4 channel 104 and 114 of the fig.1. Redundant radio channel control unit 202 is monitoring the radio-networking units all time. Once there is something happened to the radio-networking units, and the particular radio-networking unit must be blocked out, the redundant radio channel control unit 202

will block out the bad radio-networking unit and control the packet flow control unit 201 not to send any packet through out the bad radio-networking unit in the future. When the packet flow unit 201 receives packets from radio-networking units, it will repack packets and hand over to the wired ports 307,308. The packet flow control unit 201 not only can interpret the packets between the wired and wireless networking units, but also aggregates the bandwidth of the radio-networking units and forms a virtual bigger radio-networking unit.

Fig.3 is a schematic block representation of redundant wireless link formed by two RWNL devices with 4 radio channels. In this embodiment, radio1 channel 111A and 101A of the RWNL device 10A is communicating with the radio1 channel 111B and 101B of the RWNL device 10B, and forms the wireless networking link 301; radio2 channel 112A and 102A of the RWNL device 10A is communicating with the radio2 channel 112B and 102B of the RWNL device 10B, and forms the wireless networking link 302; radio3 channel 113A and 103A of the RWNL device 10A is communicating with the radio3 channel 113B and 103B of the RWNL device 10B, and forms the wireless networking link 303; radio4 channel 114A and 104A of the RWNL device 10A is communicating with the radio4 channel 114B and 104B of the RWNL device 10B, and forms the wireless networking link 304. The RWNL device 10A is connected to LAN 310 by its wired networking port 105A. The RWNL device 10B is connected to LAN 320 by its wired networking port 105B. As shown, in this embodiment, LAN 310 and LAN 320 are linked together by the wireless links formed by the two RWNL devices 10A and 10B. By the bandwidth aggregation and redundancy control of the RWNL device 10A and 10B, the wireless networking links between the 10A and 10B are working as one big wireless link between the 10A and 10B. If there is one or more than one radio channel was shutdown by the redundant control unit, the link between LAN1 310 and LAN2 320 will be impacted by reducing the bandwidth and the two networks will keep linked together.

This embodiment is an example of the point-to-point connection. When using the point to multi-point radios as the radio channels, the RWNL device can work at point to multi-point mode with the same redundancy and bandwidth aggregation features.

Preferred Embodiment – Operation

When setting up two RWNL devices to form a wireless network communication link, each of the plurality of the wireless networking radio units and the antennas must be setup to communicate with remote RWNL device. When the link is communicating,

5 each of the wireless network radio units is communicating with the correspondent radio unit of the remote RWNL device, and forms a child wireless link. The RWNL system is monitoring the performance status of each of the child links. The network flow control means controls and distributes the network packets among the child links. Once one of the plurality of the child links is underperformance or broken, the flow control means will

10 keep control and distribute the network packets among the remaining child links. The RWNL devices will report the error, and keep the communication continuously. The links are still working with redundancy, until only one child link is functioning.

Conclusion, Ramifications, and Scope

15 It can be seen that, according to the invention, I have provided a high bandwidth wireless networking link and device with multi-channel redundancy. The link achieves high bandwidth by aggregating the bandwidth of its entire child wireless links. The link is high reliable multiple redundancy, because of all the child wireless links are redundancy to each other.

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Furthermore, the Multi-Channel Redundant Wireless Network Link (RWNL) device has additional advantages in that:

- 25 • When configured with point to multi point capability wireless networking radio units, the RWNL device can form a point to multi-point backbone multi redundancy links.
- The redundancy of the Multi-Channel Redundant Wireless Network Link (RWNL) device is multiple instant redundancy, when child wireless link failed,
- 30 the redundancy is carried out by redistribute the network packets flow control means. The whole link has less bandwidth throughput, and there is no network

operation damage. The prior art of stand by dual modular redundant LMDS has a switch over redundancy delay, which may cause some network operation damage. Compared with a standby backup radio design, the RWNL device is much more robust.

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Although the description above contains much specificity, these should not be construed as limiting the scope of the invention but as merely providing illustrations of some of the presently preferred embodiments of this invention. Various other embodiments and ramifications are possible within it's scope. For example:

- 10 • By running proper flow control features, the RWNL device can turn into partially running as a high bandwidth backbone device, while having some other wireless radio units communicate with remote same type of wireless network radio devices.
- 15 • One RWNL device can run as a central backbone device by have some of its plurality wireless networking radio units communicate with one remote device to form a redundant link, the rest of its plurality wireless networking radio units communicating with another remote device to form another redundant link.
- 20 • All of the plurality wireless networking radio units can be different types of wireless networking radios, which are required not to interference with each other.
- A RWNL device can be used at indoor environment.
- A RWNL device can operate without the radio control unit.

25 Thus the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given.

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